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CONTENTS

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ABSTRACT

A survey of the east Tasmanian coastline from Musselroe Bay to South East Cape reveals 10 km^2 of *Macrocystis pyrifera* (L.) C. Agardh kelp forest. Average harvestable quantities based on Alginates (Australia) Company records (1965-72) show that cropping can expect to yield 2 tonnes/hectare or 1.23 kg/m^2. This realizes a total of 12,300 tonnes presently available on the East coast of Tasmania. Review of past records show fluctuations in total amounts harvested, due to factors such as high oceanic water temperatures with subsequent low nutrient concentrations and storm damage.

If harvesting was to proceed, the beds would have to be closely monitored, indicating the implementation of limits, controls and a concurrent research program.

INTRODUCTION

Harvesting of kelps dates back to the seventeenth century when peasants harvested kelp in France, and then spread to other parts of northwestern Europe. Driftweeds were first used but cutting was later resorted to as a harvesting technique. Kelp ash or potash was widely bought by industrialists for use in the manufacture of soap, glass and alum. In the nineteenth century it became useful as a source of iodine. The demand for potash and acetone by the United States during World War I, in the period 1917-18, brought about a rapid industrialization of the Pacific coast *Macrocystis* beds. Inventions and discoveries made during the productive war years led, by 1926, to uses for the versatile phycocolloids known as the algins. Algin is the general term designating the hydrophyllic, or water loving derivatives of alginic acid, the most commonly known algin being sodium alginate. Algin products offered commercially are soluble in water to form viscous solutions (Dawson 1966).

In the 1950's, interest was directed at the Tasmanian kelp beds as a possible alginate resource. An investigation by A.B. Cribb of the CSIRO was initiated to assess the quantities of *Macrocytsis* on the east coast. Cribb estimated a yield of 355,000 tons of wet weed per year, calculated from a predicted three harvests of the observed *Macrocystis* stocks.

Department of Sea Fisheries and Lands (unpubl.) archives record that this led to an

application by Messers Button, Chegwiddon and Kearns in 1957 to harvest the weed. In November 1958, a licence was granted to Chegwiddon and Button. In late 1960, a further survey was initiated (they had possibly realized by this stage that Cribbs original report was a gross over-estimation) and conducted by Button with a fisheries observer. Button's survey realized 33,000 tons (assuming 3 harvests per year), 10 percent of the quantity estimated by Cribb. In March 1961, the licence was transferred to Alginates (Australia) Company based at Triabunna and harvesting began in late 1963.

Records of harvests were lodged with the Departments of Sea Fisheries and Lands. These show a sustainable yield of 6-13,000 tons/year. Contrary to expectations, the majority of off-shore weed beds yielded only one crop per year. Some of the smaller in-shore beds in shallow water could be cut up to three times a year.

In 1967 a new harvesting vessel was purchased by Alginates, the Alga. This had a greater capacity and enabled more of the coast to be harvested. In 1971 Alginates applied to the Department of Sea Fisheries for an extension of their lease area for harvesting *Macrocystis* and to include Bull kelp or *Durvillaea potatorum* (Labillardiere) Areschoug on the grounds that not enough weed was being harvested to make a profit. At the same time extensions were made on the Alga to increase its range. Early in 1973, bull kelp was processed for the first time.

Late in 1973 the Alginates factory closed. This may be attributed to overcapitalization resulting in financial difficulties exacerbated by low prices for alginates on the world market, and a couple of lean years for harvesting *Macrocystis*.

In 1975, Kelp Industries on King Isand started shipping beach drift *Durvillaea* to Alginates Industries in Scotland to be processed. This industry is still is in operation today. In recent years, renewed interest has been shown in restarting an alginates industry in Tasmania. This resulted in the initiation of this survey. The aim was to determine the available stocks of *Macrocystis* on the east coast of Tasmania.

1 METHODS

Available funds limited the survey period to two weeks in late June. Initially all *Macrocystis* beds were to be surveyed from the water using a powered fiberglass dinghy, grading all beds from light to high density on 1:100,000 topographical land tenure maps using landmarks as references. Approximate widths were also noted so that areas of the beds could be calculated at a later date and using extrapolated density figures, the amount

of harvestable weed could be estimated. Bad weather shortened available time and the coast from South East Cape to Friendly Beaches was surveyed largely using aerial flights with some ground truthing.

1.1 Density calculations

Beds objectively determined as being either light (Eddystone Point), moderate (Southport Island) or high density (Fortesque Bay) were chosen to determine density for the calculation of expected harvestable tonnages. In these beds three representative 5m x 5m quadrats were marked with weighted line. The number of plants and the number of stipes per plant was recorded . The plants were then cut off at the base and returned to the boat where they were weighed with a spring balance. Values obtained were averaged and converted to harvestable tonnages by assuming 50% of the plant is collected when cut in practice.

2 RESULTS

2.1 Survey

While very little *Macrocystis* was found north of Triabunna, large beds were found south of Triabunna, at North, Lagoon and Fortesque Bays, Variety and Trumpeter Bays on Bruny Island and in the vicinity of Actaeon Is - Southport - Recherche Bay. The location of these beds and their estimated areas are marked on the accompanying map (Figure 1).

2.2 Density estimate

Results of the quadrats are presented in Table 1. This gives an unweighted average density of 2.0 kg/m^2, but this figure is not used in the calculation of harvestable tonnages. As most of the survey work was done from the air rather than from a boat as originally intended, the areas of the beds but not a grading as to their density was recorded. Harvestable tonnages were thus calculated from the actual average yield as experienced by Alginates (Australia) Company (Department of Sea Fisheries archives, unpubl.). This figure is a more conservative figure than estimated from our results. They considered an average return from a bed to be 5 ton/acre or 1.23 kg/m^2 (up to 8 tonnes/acre), Cribb 1954 estimated 4 ton/acre or 1.0 kg/m^2. To calculate harvestable tonnage from estimated areas for the purposes of this survey it was assumed that 1 ton ≈ 1tonne and 1 acre = 4046.8 m^2. Harvestable tonnage was therefore;

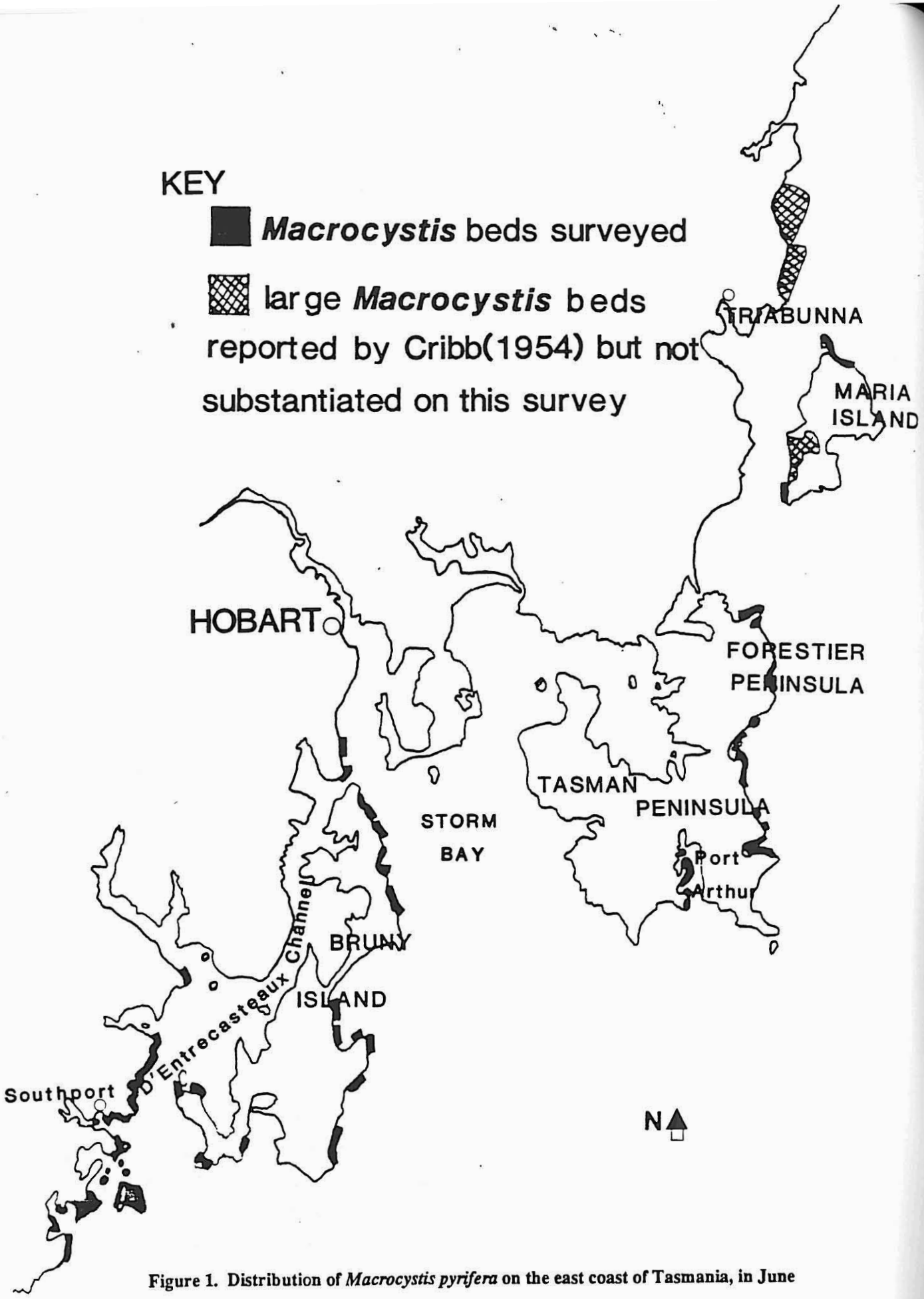

Figure 1. Distribution of *Macrocystis pyrifera* on the east coast of Tasmania, in June 1986.

Tonnage = area x 4046.8 x 1.23 / 1000

	Grading	Quadrat area (m^2)	Number of plants	Mean no. stipes/plant	Stipes m^{-2}	Total mass (kg)	Harvest kg/m^2
Eddystone Pt.	light	16	4	8.75	2.2	14.75	0.46
N. Southport Is.	moderate	25	5	21.4	4.28	81.75	1.6
Fortescue Bay	dense	25	7	19.7	5.52	200.0	4.0
						Average 2.0 kg/m^2	

Table 1. Density estimates from quadrat sampling.

2.3 Total potential yield

Table 2 gives a breakdown of the areas of the *Macrocystis* beds on the east coast as determined in this survey. The density figure of 1.23 kg/m^2, as explained above, is used to calculate harvestable amounts. This gives a total estimated harvestable tonnage for the east coast (north of Orford- negligible quantities) of 12,300 tonnes.

	Dover-Recherche	S. Bruny Is.	N. Bruny Is.	Port Arthur	E. Tasman Pen.	Forrestier Pen.	Maria Is.
Area (acres)	1,977	66	154	39	104	148	43
Tonnage	9,840	329	766	190	519	738	210

Table 2. Breakdown of total harvestable tonnage into areas.

2.4 Comparison with past surveys

Investigation of Cribb's (1954) report and past Department's of Sea Fisheries and Land records (unpubl.) reveals estimations of seaweed quantities back to 1950, including three major surveys of the stocks of *Macrocystis* on the east coast of Tasmania. The results of these surveys and the present are depicted in Table 3 for comparative purposes. Table 4 shows differences in estimated quantities at selected sites for each of the surveys.

Surveyor	Weed area (acre)	Tonnes/acre	Weed available	Cuts per year	Yearly harvest
Cribb (1954)	30,000	5	120,000	3	360,000
Button (1961)	1,993	4	11,143	3	33,429
Alginates (1965/72)	3,000	5 (approx.)		1+	6,500-14,000
Sanderson & Light	2,530	5	12,650	1.33	16,870

Table 3. Findings of major seaweed surveys of the stocks of *Macrocystis pyrifera* on Tasmania's East coast.

Area	Cribb (1954)	Button (1961)	Alginates (1965)	Alginates (1965/72)	Sanderson & Light (1986)
Grindstone Bay	8,240	140	80	525	nil
S. Maria Is.	4,064	150	20	55	10
Actaeon-Southport	58,116	310	not given	not given	1,970

Table 4. Change in estimated quantities of *Macrocystis* based on survey reports at some select sites.

3 DISCUSSION

Two significant facts to arise from these comparative exercises are:

1. the size of individual beds is very variable, yet despite this-
2. the size of the overall harvest has remained much the same.

The effect of Alginates (Australia) Co. harvesting the beds from 1965-1972 would not appear to have decreased the overall standing stocks of *Macrocystis pyrifera* on the East coast.

These results also indicate that Cribb's original estimate was a gross over-estimation. The fault is believed to lay mainly in his method of survey. This was done mainly from a small dinghy and meant that he was never able to see more than a small part of the beds at any one time, leading to overestimates of the size of the beds. Two areas that are notably different are Grindstone Bay and Oyster Cove on the southern half of Maria Island. Even before harvesting had begun by Alginates (Australia) Company in 1965, a preliminary survey by Button (initiator of the company that led to Alginates (Australia) Company being formed) in 1961 showed these beds to be a fraction of the size estimated by Cribb.

3.1 Reasons for variation in standing stocks

Reports of large beds at places from Orford north (Grindstone Bay, Friendly Beaches, Bay of Fires - reportedly 10 km long) could not be substantiated apart from small isolated patches. At Bicheno Dive Centre, divers referred to local beds disappearing in previous months. Fishermen along this section of coast alluded to a periodic coming and going of the weed and that we were at a low in the season.

Recent research on the Californian kelp beds has indicated the possible inter-relatedness of the effects of El-Niño and catastrophic occurrences in the form of storms in determining where beds occur and how prolific they may be (Dayton and Tegner

1984). Present indications are that the situation is similar here in Tasmania. Monitoring of water temperatures and nutrients in the waters off Maria Island by the CSIRO for the period from 1946 to the present show a periodic rise and fall in annual means (Rochford 1974, G. Harris *pers. comm.*). Higher temperatures indicate warmer nutrient depleted waters.

Consultation of the harvesting records for Alginates (Australia) Company (Department of Sea Fisheries archives) show a sharp decline in *Macrocystis* harvested in the years 1970/1 (see Figure 2), which was a result of a shortage of the weed and led, combined with other factors to the eventual closure of the operation. This corresponds to increased water temperatures and the consequent lower nutrient concentrations for this period (Figure 3) (Rochford 1984).

Given this observation, it may be possible to predict bad and good years for *Macrocystis* production. For example, we are at a high annual mean temperature (or low nutrient) period at present (1986, Harris *pers comm.*) thus explaining the lack of *Macrocystis* on the east coast. If the pattern continues as predicted, then following years should see greater quantities of *Macrocystis* on the east coast.

Present knowledge of nutrient regimes around the state can also lead us to predict more productive areas. While the east coast is influenced largely by the nutrient impoverished East Australian Current, areas from Southport south, are washed in the comparatively nutrient richer Sub-Antarctic waters, tthese areas may as a consequence be more consistantly productive areas.

Other factors affecting bed size at a local level in Tasmania are;

- i) storms, which can decimate *Macrocystis* beds.

- ii) substrate availability (Cribb 1954 believed one reason why *Macrocystis* often did not recur to an area was because previous available substrate had been covered by sand); and

- iii) competition between *Macrocystis* juveniles and other understory plants for substrate and more importantly, light.

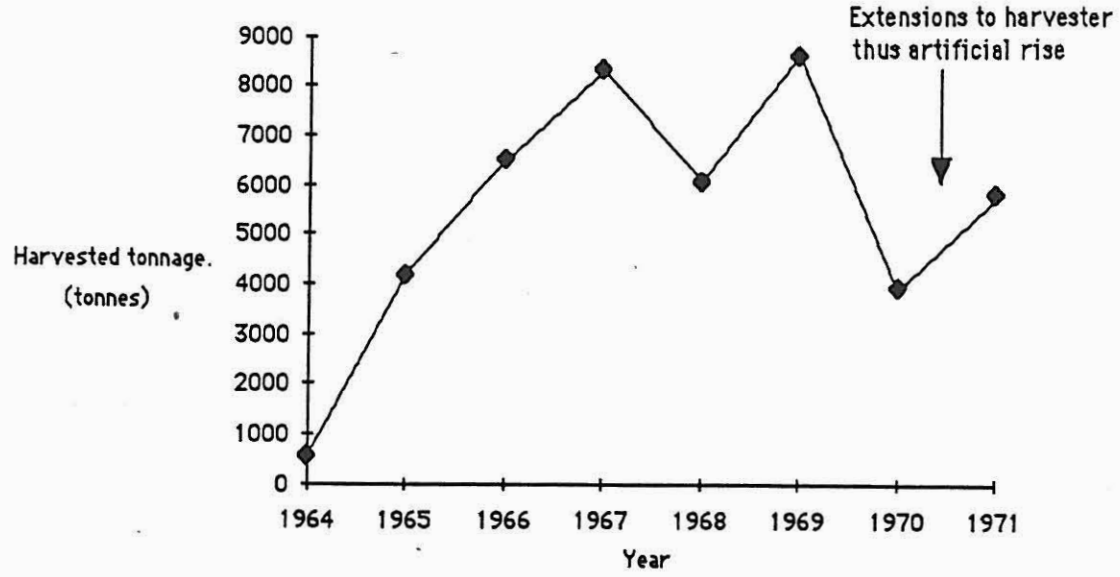

Fig. 2. Tonnes of Macrocystis harvested by Alginates (Australia) Company 1965-71.

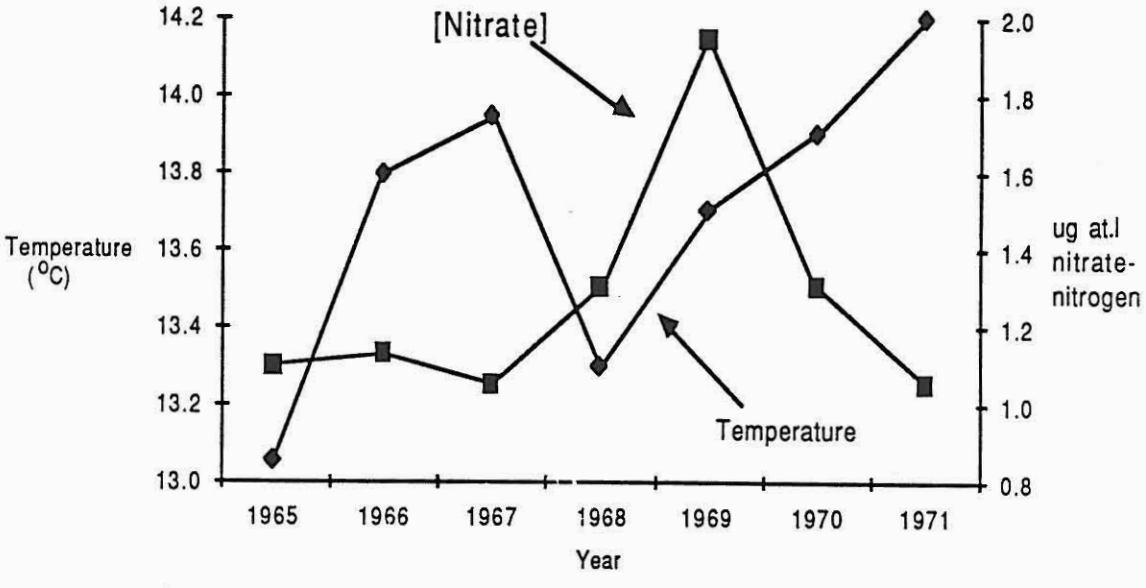

Figure 3. Annual mean temperature and nitrate concentrations measured off Maria Island by the CSIRO over the period Alginates (Australia) Company harvested (Rochford 1974).

3.2 Recommendations

Results of this study indicate a need for close monitoring of any harvesting of *Macrocystis* if the industry were to proceed, especially as over-harvesting by Alginates (Australia) Company cannot be completely discounted as a reason for their latter poor harvests. Restrictions should be considered as to the maximum number of harvests per year per bed, and the distance from the surface that the plant can be harvested. Geographical boundaries should be set to contain any potential damage at least initially, until any possible effects can be determined. Some beds should be set aside as controls and some made available for research. The Californian situation indicates that *Macrocystis* beds can be artificially regenerated (North 1976) but this may be an expensive exercise and should be avoided if possible. Further research should be conducted in parallel with any harvesting to augment present knowledge.

SUMMARY

- Results of this survey indicate present *Macrocystis pyrifera* stocks on the east coast of Tasmania to be in the order of 12,500 tonnes. Total quantities of *Macrocystis* vary annually apparently due to the effects of high temperatures and associated lower nutrient concentrations. Estimations by Bond/Olsen (Alginates (Australia) Company) of harvestable quantities ranging from 6,500 tonnes to 14,000 tonnes annually are not unreasonable.
- If harvesting were to go ahead, any effects should be closely monitored, controls implemented where necessary and a research programme conducted to support management of the industry.

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